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WIDE FIELD OF VIEW HELMET DISPLAY SYSTEMS MOUNTED FOR HELICOPTER SIMULATION

by

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Wide Field of View Helmet Display Systems Mounted for Helicopter Simulation

Zhong Lin Yi

It has been many years since simulation technology developed toward a more vivid reflection of reality. A visual coupled display system for pilots is an example of this technology. It is very crucial for reconnaissance and military helicopters to have a detailed and accurate visual information for very low altitude flight simulation. Here we will discuss WFOVHMD.

The Development of Visual Display System

Increasing the field of view has been the goal for a longtime. It is ideal for a pilot to have a complete image on his surroundings. The field of view display system in early simulation uses limited projecting screen(48°x37°), images are then transmitted to simulation projectors by closed circuit video camera. CRT/electron beam based camera/simulation system also has a limited field of view. The rise of CGI in the 70s made it possible to a have wide field of view. The display system of CGI contains CRT window and globe screen.

In order to lower cost, only part of the actual field of view is displayed instead of filling the screen with whole field of view. Such kind of partial field of view is called "detection span". This requires monitoring the head and eye position of an observer. This is so called visual coupled system.

A helmet-mounted laser projector is an early form of visual coupled globe screen system. A projector on a pilot's helmet

projects the view on the globe screen. Optical fibers transmit images recorded by tracking the pilot's head position. The newly developed eye tracking and viewing technology has captured public attention with its high precision partial region detecting images.

Ordinary flight simulators adopt either globe projector or CRT window, both of which require high standard assembly. Thus it is difficult to produce images with sufficient intensity on a big surface. Most projection systems produce an intensity in a range of Kandira/m2——. This does not seem to be a problem in a visual coupled helmet mounted display system, or a wide field of view helmet mounted display system (WFOVHMD).

Visual coupled helmet display systems can provide a pilot with tremendous amount of visual information. In the past, development of helmet mounted system used to aim at display scanning images of airplane's probing systems. It was only in the last few years had it was used in flight simulations. In comparison to a twelve CRT projector display system, the uniqueness of the application of helmet mounted display system in a simulator lies in consolidation of all images. This results in a different kind of high precision visual information. On the same monitor both flight environments and figure display can be seen. This means figures and digital information can be overlayed with the display of field of view, indicating the operating condition of the cockpit. Moreover, this will enable the pilot to realize the capacity of simulated helicopter and enable him to get a better feel about the size of an actual helicopter.

The wide view helmet mounted display system with a broad detection span will have a significant impact on future reconnaissance and military helicopter simulation. Future

cockpit technology will increasingly rely on synthesized images, multi¬function figures and figure display, night scanning and other specialized systems. While cockpit technology and simulation technology become increasingly indistinguishable, WFOVHMD seems to have unrestricted detection span, compact structure. It can control and enhance night vision. Use of helmet mounted display in simulation training will more accurately reflect actual condition of a real flight.

Use of a Simulator in a Study of Helmet Display

In order to deal with key missions, compatibility of pilot and airplane of the next generation of reconnaissance and armed helicopter, a visual coupled WFOVHMD simulation test was conducted in a simulator developed jointly by CAE Corporation and Ames Research Center of NASA. It used a light weight, custom designed helmet with two groups of helmet optical devices. A color image with digital display on flight and system is transmitted to the helmet optical devices through two bundles of optical fibers by four high /58
intensity light switched projectors. This system integrated a software which can screen out images on the interior of the cockpit in order to simultaneously display cockpit and viewing image. The movement of head/helmet is tracked by infrared light monitor. The angular frequency detector behind the helmet can give an early prediction which can compensate for the delay in transmission of the images. The horizontal angle of helmet is 120°, vertical angle is 67°, the range of detection can be expanded to 360°. Computer imaging system Compus-Cene IV can give a pilot views on flight routes and environments. It can also simulate the noise effect of front infrared light detector, resolution, automatic and manual control, contrasting black and white

images, floating images, effect of temperature and time at day and night, detectors' position on a simulating airplane.

CSRDF can be used to check requirements for visual coupled helmet display compatibility by pilot, WFOVHMD can be used to achieve maximum visual information and to guarantee flight safety. The parameters that are used to judge visual display systems are:instant field of view, detection span, resolution, intensity, transmission, monocular or binocular display, discrepancy between a pilot and detectors. In practice, determination of the most optimized parameters relies on a series of studies compromised by partial and whole task simulator, such as a compromise between field of view and resolution, monocular and binocular observing condition, intensity of image and transmission.

The simulation process also involves checking direction loss caused by pilot and detectors, and misalignment between image and actual positions of object in space.

Simulation of Visual Coupled WFOVHMD

1. Extreme Closed Caption

Low flight often requires close monitoring objects and landscape in the view. Visual coupled WFOVHMD enabled a pilot to visualize the object near the sides of an airplane. In the past, it was difficult to simulate operation in "stationary blind region" after lateral movement. With WFOVHMD, this can be easily done. The high resolution and capability in observing extreme close landscape by WFOVHMD, combined with computer imaging system, enable a pilot to make a vertical movement within 10 cm with great precision.

Such a visualizing capability has a profound impact on both training and research. It can alleviate confusion by a pilot who associates with a lack of in-depth viewing in maintaining freezing position in the air. By doing such a simulation, pilot can achieve the same level of training as in an actual flight. Researchers can use simulation to study flight control which is something unimaginable in the days when visual feedback was lacking.

2.Target Display

Due to constraints in the field of view and detection span, target display is limited in the systems based on CRT or globe screen. Targets have to be lined within the CRT window or have to be within the projection region of the globe screen. In order to track targets, especially air targets, pilots have often to make huge physical adjustments to make up for the limit of detection span, and to keep the targets locked in their view. WFOVHMD makes it possible for pilots to track the targets at any position on the globe screen by turning his head without adjusting direction of simulated flight. For example, pilots can now see some traditionally blind regions of simulators, such as the upper and the back positions of airplanes.

WFOVHMD can make the transition from simulator to flight actual airplanes faster, since pilots do not need to relearn visual scanning tactics needed in actual flight which are inadequate in simulation training.

3. Head Aiming

Advanced military helicopters use the head in aiming during flight. Thus an aiming/capturing helmet display system is needed for target capturing system and capturing simulation research. The head tracking system also provides researchers

with another potential use: estimate change of searching methods by pilot using data obtained from head movement.

Simulator, Airplane and Their Application in Training

Pilots can train in the cockpit by connecting an airplane and a simulator with control cable. The control signals are processed by a computer in the simulator and are displayed on the monitor and HMD of the pilots. This can also be used in group training,during which crews can operate their planes and coordinate flights with one another.

Pros and Cons.

WFOVHMD totally changed low intensity and limit in detection span that are associated with previous simulators. In conjunction with detectors on an airplane, it can recognize and aim at a target all by itself. But helmets vary from each individual and weigh quite a bit, and need quite a length of time in setting up, and appropriate optical adjusting.

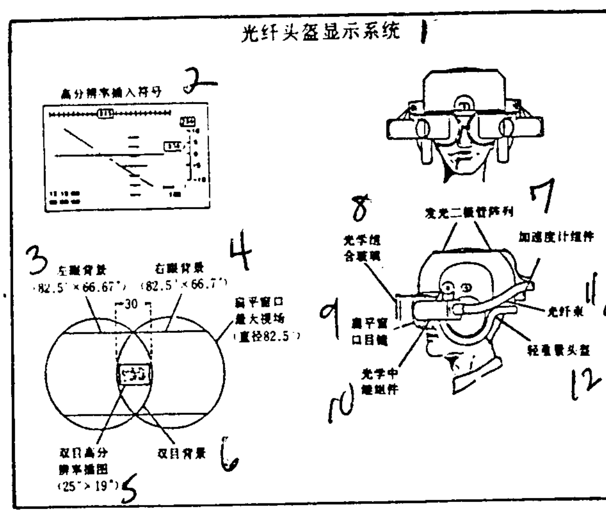

Fig.1 WFOVHMD System Simulator
Key: 1. Optical Fiber Display System; 2. High definition figure input; 3. left eye image; 4. right eye image; 5. Binocular high definition figure (25° x 19°); 6. *Illegible;* 7. Light emitting bipolar transistor; 8. Composite optical fiber; 9. glass; 10. 11. flat object; 12. lens.

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